The Pairing of Trigger Point Dry Needling with Rehabilitation Techniques

Karle Kotze

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Honors Program of Liberty University.

Dr. David Titcomb, PT, DPT, EP-C
Thesis Chair

Dr. Jeffrey Lowes, DC, CSCS, EP-C
Committee Member

Dr. Michael Smith, Ph.D.
Committee Member

Emily C. Knowles, D.B.A.
Assistant Honors Director

Date

Abstract

Trigger point dry needling is a manual treatment modality used for individuals experiencing tightness, pain, and inhibited range of motion in any region of the body. Dry needling can be described as the insertion of a blunt, microfilament non-medicated needle into the skin for the purpose of targeting specific muscles, which contain tight bands known as trigger points. When the needle is inserted into the trigger point the muscle contracts, holds tight to the needle, and elicits a neural twitch response. This ultimately causes the muscle to relax, allowing for reduction in pain and improvements in range of motion. Although the use of dry needling is rising in popularity in the United States, knowledge of its use and effects is limited. Fortunately, more research is being conducted on this form of treatment. In this thesis, the purpose and physiological effects of dry needling will be discussed in detail, along with a comparison between other alternate medical modalities of treatment which target trigger points. In addition, current research on the effectiveness of incorporating dry needling with other manual therapeutic modalities will be discussed. Dry needling has been shown to be very effective in treating trigger points by improving range of motion, decreasing pain, reducing muscle tightness, and increasing muscle oxygenation. Positive effects of dry needling are even more likely to occur when paired with other modes of therapeutic treatment, often in a physical therapy setting but may also be performed by other health professionals including chiropractors, athletic trainers, occupational therapists, and physicians.

The Pairing of Trigger Point Dry Needling with Rehabilitation Techniques

Musculoskeletal pain is an increasing epidemic in today’s society, likely due to mechanical overload, psychological stress, sedentary lifestyle, or extended periods of time spent in static posture leading to muscle tightness. Musculoskeletal pain is often manifested in the shoulders, neck, and back (Ziaeifar, Arab, Karimi & Nourbakhsh, 2014). According to Akamatsu et al. (2015), myofascial pain syndrome (MPS) is defined as hyperirritability in a focused area of muscle tissue. Since there is a scarcity of research on the topic of MPS, it is not yet formally accepted as valid and this type of pain is often improperly diagnosed (Akamatsu et al., 2015). Up to 85% of musculoskeletal pain is caused by myofascial trigger points (MTrPs) (Ziaeifar et al., 2014). These trigger points are a direct result of MPS and may be defined as painful, sensitive, and irritable knot-like spots in a taut band of muscle, often tender to the touch and eliciting a grimacing response when palpated with pressure (Ziaeifar et al., 2014). In addition, they may be classified as either active or latent in nature. According to Ziaeifar, Arab, Karimi, and Nourbakhsh (2014), active trigger points are sensitive at rest and pain is typically not felt directly on the trigger point origin. Latent trigger points, on the other hand, do not cause pain at rest but are painful when pressure is applied and also cause muscle weakness and restrict range of motion (ROM) (Ziaeifar et al., 2014). Extremely low oxygen saturation (less than 5% of normal levels) paired with highly acidic tissue environment at the site of the trigger point has been observed to prevent the affected muscle from working efficiently due to negative effects on Acetylcholinesterase (AChE), calcium ions, and Acetylcholine (ACh) involved in muscle contractions (Ziaeifar et al., 2014). Trigger points can be found in any muscle of the body but are most often found in the neck and shoulder region, specifically in the upper trapezius muscle (Ziaeifar et al., 2014).

One clear identifier of a MTrP is the twitch response that occurs when the trigger point is treated upon with modalities such as deep palpation, pressure, massage, or needling of the taut band of muscle (Ziaeifar et al., 2014). This twitch response is the result of an involuntary spinal cord reflex reaction that forces the tight muscle fibers to contract. While several treatment protocols have been used to treat individuals with musculoskeletal pain related to MTrPs, no one treatment modality has been proven as definitively superior over the others (Ziaeifar et al., 2014). The history and theory of trigger point dry needling (TPDN), its scientific effects, and its paired effects alongside various treatment modalities such as ultrasound therapy, manual pressure techniques, and therapeutic exercise will be discussed in this thesis, with the purpose of determining the effectiveness of dry needling (DN) alongside traditional physical therapy practices.

History and Theory of TPDN

In 1941, researcher Michael Kelly set out to test the effects of local anesthesia treatment in individuals with fibrositis and allied disorders. Kelly noted that the anesthetics produced the same effect as simply injecting a normal saline or placebo to treat myofascial pain (Unverzagt, Berglund, & Thomas, 2015). In 1942, Janet Travell conducted similar research on the use of MTrP injections. Like Kelly, Travell also found that trigger point injections showed no significant difference from placebo. Although contrary to the original hypothesis, these results ultimately helped lead to the development of modern DN (Dommerholt, 2004). Forty years later, in 1979, Karel Lewit from Czechoslovakia performed research that has also become fundamental in the origin of modern TPDN. Lewit implemented DN treatments on 241 individuals and found that 86% of cases resulted in immediate pain relief when injected with a non-medicated needle (Unverzagt et al., 2015). Ultimately, the effects of DN were not due to the injected medication, but were primarily due to mechanical stimulation of the trigger point with the needle (Dommerholt, 2004).

The scientific basis and techniques of DN as treatment of neurophysiological pain are historically based on three different models, including a radicular model, a spinal segmental sensitization model, and a trigger point model (Unverzagt et al., 2015). Chan Gunn, a Canadian physician, contributed to the early exploration of DN through experimental research and development of the first model, the radicular model. This model, created in 1973, is based on Gunn's hypothesis that myofascial pain can always be traced back to neuropathy or radiculopathy. Radiculopathy is also commonly known as a pinched nerve or nerve pain radiating out from the spine. The radicular model is based on the Law of Denervation, which states that the health and functionality of innervated structures depends on unhindered flow of nerve impulses and results in a regulatory effect (Unverzagt et al., 2015). On the contrary, when nerve flow is inhibited it leads to increased irritability to chemical agents in each affected structure, along with increased atrophy and hypersensitivity (Dommerholt, 2004; Unverzagt et al., 2015). Gunn states that striated muscles are the most sensitive innervated structures, making them the "key to myofascial pain of neuropathic origin" (Dommerholt, 2004, p. 17). This neuropathic hypersensitivity may result in the muscle fibers overreacting to chemical and physical inputs like stretching and pressure (Dommerholt 2004). The irritability to chemical agents causes muscle shortening in the extensors of the back, which may result in disc compression, pressure on nerve roots, or narrowing of intervertebral foramina (Dommerholt, 2004). Additionally, Gunn observed that DN treatment points are always close in proximity to musculotendinous junctions and distribution of these points are myotomal, or related to a group of muscles innervated by a singular spinal nerve (Unverzagt et al., 2015). This led Gunn to deduce that MTrPs do not play a vital role in the radiculopathy model (Unverzagt et al., 2015). While many of Gunn's initial hypotheses have been contradicted by more recent research, these findings have played a major role in the development of DN, specifically in terms of nerve dysfunction and neuropathy as they relate to myofascial dysfunction (Dommerholt, 2004).

Dr. Andrew Fischer was the creator of the second model: the spinal segmental sensitization model (Unverzagt et al., 2015). This model incorporates aspects of Dr. Janet Travell and Dr. David Simons' trigger point model as well as Chan Gunn's radiculopathy model (Dommerholt, 2004). Similar to Gunn's belief, Fischer claimed that nerve root compression and foraminal space narrowing are the result of spasms of the back extensor muscles (Unverzagt et al., 2015). Contrary to Gunn's model however, Fischer held the belief that local anesthetic injections are the best way to achieve long-term benefits in the relief of muscle pain and tenderness (Unverzagt et al., 2015). Therefore, Fischer used injection needles rather than the thin acupuncture needles used by Gunn and also acknowledged the significance of MTrPs, as opposed to Gunn's dismissal of their importance (Unverzagt et al., 2015). The spinal segmental sensitization model uses infiltration of, or injection to, the supraspinous ligament to relax taut bands of muscle and inactivate tender spots (Dommerholt, 2004). Fischer claims that pre-injection nerve blocks, needle and infiltration techniques, as well as certain stretch and relaxation exercises are the most effective in reducing musculoskeletal pain (Dommerholt, 2004). These injection techniques were believed to "mechanically break up abnormal tissue" (Dommerholt, 2004. p. 17).

The trigger point model is the third and most commonly used model, formulated by Dr. Janet Travell (Unverzagt et al., 2015). The main goal of this model is the relief of sensory, motor, and autonomic abnormalities through the targeting of MTrPs. According to Travell's research, DN is the most effective method to deactivate MTrPs and thereby reduce musculoskeletal pain (Unverzagt et al., 2015). The local twitch response plays a large role in the effectiveness of DN, as it is believed to relieve pain by interrupting motor end-plate noise (Unverzagt et al., 2015). Motor end plate noise, also known as monophasic end-plate activity, may be defined as low duration and low amplitude negative electric action potentials that remain steady and non-propagated (Daube, 2002). Measured through needle electromyography, motor end plate noise is essentially an interruption in action potentials at the neuromuscular junction during neural firing and can be identified by a static-like sound heard through the monitor (Simons, Hong, & Simons, 2002). This phenomenon is often characteristic of MTrPs and has been correlated with hyperirritability and muscle weakness (Simons et al., 2002). This response is believed to be vital in transforming the chemical environment of a MTrP, which can be physically observed through patients' report of instantaneous reduction in pain after DN (Dommerholt, 2004). Mechanical stimulation of trigger points through DN under this model is most effective when paired with other treatments including stretching, muscle strengthening, joint mobilizations, and neuromuscular re-education (Unverzagt et al., 2015). The benefits elicited through the localized twitch response include relaxation of actin-myosin bonds, normalization of muscle tone and neurological interface, and improvements in AChE flow within the muscle (Unverzagt et al., 2015).

DN Versus Acupuncture

Although there are a limited amount of studies that compare and contrast traditional acupuncture (TA) vs TPDN, several specific similarities and differences have been identified. The main likeness between TA and TPDN is that they both involve the insertion of solid filiform needles into the skin for therapeutic purposes. They are somewhat similar in some of their techniques and theories, but they have many more differences than similarities. According to Zhou, Ma, and Brogan (2015), TPDN is specific to musculoskeletal pain and is mainly practiced by physicians, chiropractors, and physical therapists. TA, on the other hand, has been used to treat a wider range of medical conditions but is only practiced by acupuncturists. Neither practice involves any medicinal injection, but both have their own procedure and method of identifying injection points. TA needling points are based on the meridian concept and the balancing of Yin and Yang, while TPDN insertion points are based on the anatomy of myofascial pain and trigger points (Zhou, Ma, & Brogan, 2015). TPDN involves a fast needling approach know as “pistoning,” while TA utilizes needle retention in which needles are left in the patient for 30-45 minutes (Zhou et al., 2015). Additionally, there are significant differences in the purpose behind administration of DN versus that of acupuncture. According to Liu, Skinner, McDonough, and Baxter (2016), the goals of TA include regulating the balance of energy, addressing underlying causes of pain, and prevention of future conditions and diseases. MTrP needling on the other hand, seeks to deactivate trigger points in muscles and eliminate pain related to nerve cell stimulation as well as focusing on the treatment of symptoms (Liu, Skinner, McDonough, & Baxter, 2016).

Myofascial Trigger Points

Pathophysiology of MTrPs

In a 2015 study, Akamatsu et al. speculated that MTrPs may have to do with muscle innervation. Researchers used 12 human cadavers to examine the dorsal primary rami, which branch off of the spinal nerve and innervate the trapezius muscle. After long hours of dissection and examination of the nerve and muscle fibers, researchers found that the innervation point where the nerve reaches the muscle was the same location of previously identified MTrPs. The study's hypothesis was confirmed in this finding, that the innervation point at the muscle coincides with the MTrP, indicating that the two may be correlated. Researchers suspect that this finding along with the understanding of the anatomical basis of MTrPs will contribute to future research on this topic. It may also help in the formation of a precise map for clinical treatment of similar types of painful disorders (Akamatsu et al., 2015).

Location and Diagnosis of MTrPs

According to Akamatsu et al. (2015), trigger points may be found anywhere in the body, but are usually found near the motor endplate of a skeletal muscle and are most often seen in the trapezius muscle. Trigger points originating here often cause limited ROM and referred pain in which symptoms spread to other areas of the body such as the neck, shoulders, back, and proximal portion of the arms. More referred areas of pain include headaches, pain and dysfunction of the temporomandibular joint, inhibited cervical movement, and dizziness (Akamatsu et al., 2015).

Prior to diagnosis and treatment of MTrPs, the clinician must have knowledge of the anatomical location of where trigger points might arise in a particular muscle (Akamatsu et al., 2015). Consideration of the patient's history of pain and performing a physical examination are the best ways to begin identifying MTrPs (Lavelle, Lavelle, & Smith, 2007). Lavelle, Lavelle, and Smith (2007) identified eight characteristics of MPS to be considered during diagnosis and location of MTrPs. The first characteristic involves listening to the patient's subjective description of the onset of pain followed by objectively examining the pain distribution and identifying the most intensely painful point. Next, the clinician identifies referred pain patterns following the palpation of MTrPs and takes note of whether or not the referred pain is reproducible when the MTrP is mechanically stimulated. Restricted ROM, Muscle weakness due to pain, and pain with compression are also indicative of the presence of a MTrP. Lastly, the location of a palpable taut band of muscle and a local twitch response brought on by needle insertion denote that the pain experienced by the patient is related to MTrPs (Lavelle et al., 2007).

For further detection of MTrPs, Lavelle et al. (2007) identified three palpation methods: flat palpation, pincer palpation, deep palpation. The flat palpation technique is when the clinician slides a finger across the affected muscle fiber, pushing the skin to one side. If present, the clinician will feel the taut band of muscle passing under their fingers. The second technique is called pincer palpation. This method requires the clinician to firmly grasp the muscle using the thumb and forefinger, rolling the muscle fibers while locating the taut band. The third method is called deep palpation and is used to locate MTrPs obscured by superficial tissue. In this technique, the clinician places a finger over the area of the muscle that is thought to contain the MTrP. If the pain and symptoms are recreated when pressure is applied to this area, it is assumed that a trigger point is present (Lavelle et al., 2007).

Cause of Pain in MTrPs

According to Edwards and Knowles (2003), musculoskeletal pain caused by trigger points often progresses to chronic conditions if left undiagnosed. If normal healing does not occur, increased local tenderness will progress to referred pain. One hypothesis that could help explain how trigger points create pain is their effect on nerve endings to release excessive amounts of the neurotransmitter acetylcholine (ACh) at the motor end plate. Excessive ACh negatively impacts calcium pumps in the muscle, causing prolonged sarcomere contraction. This sustained contraction places pressure on local blood vessels, compressing them and inhibiting oxygen flow, thereby resulting in an energy crisis. This crisis is fueled by the increased demand from the sarcomeres and decreased oxygen supply due to local hypoxia. It has been suggested that the activation of A-delta nerve fibers inhibits pain signals conveyed from the trigger point by muscular C-fibers when the needle is inserted during a DN procedure. This also consequently relaxes the previously taut muscular band and resolves the energy crisis at the motor end plate (Edwards & Knowles, 2003).

According to Simons (2002), it is important to first identify MTrPs as the cause of pain in an individual. MTrPs are an extremely common cause of many different types of musculoskeletal pain, yet they are also highly overlooked. It is typical for patients to be diagnosed with pain, but the cause of pain is often not recognized or addressed. As previously stated, MTrPs are hyperirritable sections in a taut band of muscle. Increased tension in this taut band is a result of the trigger point and causes muscle tightness, reduced ROM, and is commonly mistaken for muscle spasm. This increased tension leads to shortened sarcomeres in the muscle, which compensate by overstretching the remaining sarcomeres that were unaffected by the MTrP tension. Manual therapy and slow, gentle stretching can be implemented by a trained clinician to help restore affected sarcomeres back to their original length. One method of releasing pressure within trigger points involves direct digital compression to the trigger point until the therapist feels the release of pressure. As a result, increased ROM and reduced muscle tension ensues (Simons, 2002).

Scientific Effects of DN

DN involves intramuscular stimulation by a solid filiform needle to treat pain from active MTrPs. Since there is a paucity of research on DN, there is currently limited evidence to explain the science behind TPDN. From a scientific standpoint, the precise explanation of how DN deactivates trigger points is not fully understood. However, physiological effects of DN can be observed in the taut band of the muscle, the blood flow to the muscle and surrounding areas increases, and the nervous system is positively influenced to reduce perceived muscle pain (Cagnie et al., 2013). DN affects the taut band when the needle is inserted and prompts a local twitch response, altering the length and tension of the muscle fibers. It has also been found to increase blood flow and oxygenation in the muscle as well as elicit changes in both the peripheral and central nervous system at the site of the muscle (Cagnie et al., 2013).

Ziaeifar et al. (2014) cited other studies that have shown that individuals performing prolonged sedentary tasks such as sitting at a computer tend to demonstrate reduced local oxygen saturation in the muscles as well as increases in lactate production. As a result, this can manifest in the form of neck and shoulder pain. Oxygen saturation levels within a trigger point have been measured to be less than 5% of the normal oxygen saturation level (Ziaeifar et al., 2014). Additional research on blood flow and oxygen saturation in muscles before and after DN treatment found an increase in these variables within the muscle for up to 15 minutes after the removal of the needle from each trigger point (Cagnie et al., 2012). Ziaeifar et al. (2014) found that one week after DN was administered to trigger points in the muscle, patients' pain intensity had notably decreased from the levels recorded prior to treatment (Ziaeifar et al, 2014).

Comparing Common Modalities for MTrP Treatment

Ultrasound Therapy

Ultrasound therapy is widely used throughout physical therapy treatments. Ultrasound uses deep heating effects to cause vasodilation, increase metabolism and viscoelasticity, and help decrease pain and muscle spasms (Aridici et al., 2016). Aridici et al. (2016) conducted a study in which they treated MTrPs using high-power pain threshold ultrasound therapy. Ultrasound waves were applied for an extended period of time with increasing intensity until maximum threshold was reached. In this group that received ultrasound therapy, the probe was held stable at threshold for 3 seconds before the intensity was reduced to half and then spread around for 15 seconds before dosage was increased to threshold again. This was repeated three times. After evaluation of the results, researchers found high-power pain threshold ultrasound therapy to be effective in reducing stress levels and pain as well as improving ROM and quality of life. A possible limitation to this measurement, however, could involve the heating effect that is present in ultrasound therapy. It is possible that decreased muscle stiffness recorded in this study could be attributed to increased tissue elasticity due to the application of heat (Aridici et al., 2016).

Dry Needling

Aridici et al. (2016) compared the effects of high-power pain threshold ultrasound therapy against responsiveness to TPDN in order to determine which modality is more effective. After locating each trigger point and preparing the surface of the skin, a needle was perpendicularly inserted through the skin and into the subcutaneous tissue, reaching the targeted muscle and causing a twitch response. This was repeated 8-10 more times through rapid inward and outward movements of the needle, a method known as pistoning. After evaluating the results of the group that received high-power pain threshold ultrasound therapy and comparing to the group who had received DN therapy, results indicated that high-power pain threshold ultrasound therapy was more effective in reducing stress level than DN. However, both ultrasound and DN were equally effective in pain reduction, improved ROM, and quality of life, ultimately indicating that neither approach was superior to the other. Researchers in this study concluded that both DN and ultrasound therapy are effective in treating MTrPs in MPS (Aridici et al., 2016).

Meulemeester et al. (2017) conducted a study comparing TPDN and manual pressure in the treatment of myofascial pain. The purpose of this study was to determine whether DN has a better effect than manual pressure on pain and muscle characteristics in female office workers with myofascial shoulder and neck pain. Subjects were eligible for the study if they performed at least 20 hours per week of computer work. Participants were separated into two groups. Group one received DN treatment and group two received manual pressure treatment and each group underwent one treatment session per week for 4 weeks. Four major factors in the upper trapezius muscle were measured throughout the study: pain pressure threshold, tone, elasticity, and stiffness. Pain pressure threshold was evaluated using algometry by applying a specific amount of pressure to each trigger point site and subjects were asked to rate their pain on a numeric rating scale of 0-10, with 10 being the most pain. In the DN group, subjects were asked to lie in a prone position with hands by their side. The therapist performed DN at each trigger point until achieving a twitch response. Researchers concluded that the group receiving DN showed long-term improvements in neck functionality and decreased general pain scores via numerical rating scale. Short-term improvements were observed in the pressure pain threshold and muscle elasticity (Meulemeester et al., 2017).

Manual Pressure

Manual pressure therapy has been used to help treat pain related to MTrPs. According to Meulemeester et al. (2017), this technique involves the therapist applying increasing pressure on the surface of the body directly at the trigger point site. Manual pressure therapy results in reactive hyperemia and spinal reflex mechanism and is thought to be responsible for relieving pain and releasing muscle spasms caused by MTrPs (Meulemeester et al., 2017). Meulemeester et al. (2017) compared DN to manual pressure, measuring manual therapy by asking subjects to sit in a chair with hands placed on thighs while the therapist placed the apex of a wooden cone on each of the patient's trigger points. Pressure was applied at 10 N/s until maximum tolerance was reached and pressure was then maintained for 60 seconds. Based on clinical experience with DN, researchers had hypothesized that the local and specific characteristics of this method along with its accessibility to deeper muscles would result in greater short-term and long-term treatment effects as opposed to manual pressure therapy. However, researchers concluded, contrary to their original hypothesis, that DN was no more effective than manual pressure. Both methods resulted in similar improvements in neck disability index, general pain scores, pressure pain threshold, and muscle elasticity and stiffness (Meulemeester et al., 2017).

DN and manual pressure resulted in a similar decrease in pain; however, other research on this is conflicting. In a different study cited by Meulemeester et al. (2017), researcher Llamas-Ramos observed a greater increase in pressure pain threshold following DN as opposed to manual pressure, but there is conflicting research on this as well. Researchers suspect that the similarities between the DN and manual pressure groups could be attributed to the fact that the treated muscles in this study were superficial muscles, making them equally accessible for both techniques. Overall, researchers did not find DN to be more effective than manual pressure, but did conclude that both treatments resulted in reduced disability, improved general pain scores, increased pressure pain threshold, and improved muscle elasticity and stiffness (Meulemeester et al., 2017).

Foam Rolling

Another method for myofascial release is foam rolling, a type of self-myofascial release that may be performed by the individual independent of the clinician, using a foam roller as a tool. This method has been found to increase ROM, reduce muscle soreness, and even improve arterial function and nervous system activity (Beardsley & Skarabot, 2015). Roylance et al. (2013) conducted a study comparing how joint ROM is acutely affected by a combination of self-myofascial release in the form of foam rolling, postural alignment exercise, and static stretching (Roylance et al., 2013). The purpose of this study was to identify whether foam rolling would relax muscles, decrease overactive myofascial tissue, and consequently increase joint ROM in college-aged adults. All subjects included in this study were university students between the ages of 18 and 27 lacking proper joint ROM, particularly with a sit-and-reach stretch measurement of 13.5 inches or less. Participants were tested in two separate sessions, each of which included three separate sit-and-reach measurements. Session one consisted of a pre-test sit-and-reach measurement followed by a foam roll treatment and a second sit-and-reach measurement. Then the subject performed either a postural exercise or a static stretch treatment before the third and final sit-and-reach stretch was measured. Session two was completed 24 to 48 hours later, with the only difference being the order of treatments. The initial sit-and-reach was measured, a postural exercise or static stretch treatment was performed, a second sit-and-reach measurement was taken, a foam-roll treatment was performed, and a final sit-and-reach test was administered. Subjects used a cylindrical foam roller on the low back, upper back, buttocks, posterior thigh, and calf as these muscle groups may all have an affect on the patient’s ability to perform the sit-and-reach test. The subjects demonstrated that the addition of foam rolling to either postural alignment exercises or static stretching produced the greatest results, producing an acute increase in joint ROM in college-aged students (Roylance et al., 2013).

Instrument-Assisted Soft Tissue Mobilization (Graston Technique)

According to Gulick (2018), a clinician may perform instrument-assisted soft tissue mobilization on a patient using special tools with beveled edges in a multidirectional stroking pattern to help mobilize soft tissues in the body. In his research, Gulick sought to explore the effects of instrument-assisted soft tissue mobilization specifically as it relates to MTrPs. Before testing, the pressure sensitivity of each myofascial trigger point was measured. After identification of MTrPS in the upper trapezius, subjects were randomly placed in either the control or the intervention group. Those in the control group received no treatment, while those in the intervention group received 6 treatment sessions over the three-week study period. Each session lasted a total of 5 minutes. This time was composed of 1 minute of sweeping through stroking motions parallel to the muscle fibers with a single beveled handle bar tool, 1 minute of swivel through a pivoting motion back and forth over the MTrP using the same tool, 2 minutes of fanning using a convex single beveled tool through a semi-circular motion, and 1 more minute of sweeping to end the treatment session. During post-testing, subjects demonstrated a slight decrease in pain pressure threshold for MTrPs in the control group, while an increase in pain pressure threshold for MTrPs was shown in the group the received instrument-assisted soft tissue mobilization. Additionally, this technique helped to increase subjects' tissue temperature and blood flow, reduce muscle spasms and related pain, and increase ROM (Gulick, 2018).

Selecting Appropriate Treatment Modalities

Research is still developing in the area of MPS and much more research still must be conducted before a conclusion can be made as to which treatment modality is the most effective in terms of pain related to MTrPs. Ultrasound therapy, TPDN, and manual pressure therapies have all proven to be effective in treating MTrPs through decreased muscle stiffness, increased joint ROM, increased pressure pain threshold, decreased general pain scores, reduced stress levels, and increased quality of life. Side effects of each treatment are negligible, with the most negative effect being short-term muscle soreness. While all three methods have been found to be equally effective, not every treatment is ideal for every patient. Each patient's special considerations must be taken into account before a treatment modality is prescribed. DN should not be used for patients with blood-clotting diseases, those who take medications that affect blood closing or blood viscosity, or individuals with a psychological fear of needles. Since treatment effectiveness is so similar in these three techniques, the best method should be discussed and decided upon between the patient and therapist.

Additionally, in the clinical physical therapy setting it is believed that manual therapy generally should not be used in the elderly population. While not much research has been published on this topic, it would be beneficial to see what research would show regarding the safety and effectiveness of DN and other types of manual therapy on the geriatric population.

Pairing DN with Other Manual Medical Practices

DN and Manual Compression

Post-needling soreness is highly prevalent, especially after deep DN of latent MTrPs (Martín-Pintado-Zugasti et al., 2015). Martín-Pintado-Zugasti et al. (2015) conducted a study to determine effective methods for reduction in post-needling soreness, specifically the use of manual compression after trigger point injections. Researchers compared the effects on cervical ROM after manual compressions alone, after DN with placebo, or after DN alone. The use of ischemic compression was found to reduce post-needling soreness. Improvements were also seen in cervical ROM after treatments of ischemic compression with TPDN as opposed to DN alone (Martín-Pintado-Zugasti et al., 2015).

Arias-Buría et al. (2015) conducted a study on individuals experiencing postoperative pain following proximal shoulder surgery. Subjects were separated into two groups where they either received physical therapy alone or physical therapy plus TPDN. The addition of a single DN session to the first physical therapy treatment was found to improve the recovery rate of postoperative pain and functionality. Results of related studies combining TPDN with manual therapy also prove reduced pain and improved muscle function after re-evaluating patients two months post-treatment (Arias-Buría et al., 2015).

DN and Active Stretching

Edwards and Knowles (2003) tested the hypothesis that DN paired with active stretching would be more effective in reducing myofascial pain than each treatment independently. Researchers hypothesized that using slow active stretches would help restore full ROM in the affected muscles and lead to a more complete recovery. All subjects involved were at least 18 years of age and presented at least one active trigger point. Subjects were randomly divided into three groups, one receiving both DN and active stretching exercises, the second receiving only stretching exercises, and the third receiving no treatment. In group 1, sterile stainless steel acupuncture needles were inserted at a depth of 4 mm and the procedure was repeated over a 3-week period at various frequencies depending on the severity of each subject's condition and a follow-up assessment was performed at the end of week 6. In groups 2 and 3 patients were prescribed 3 stretches to be performed 3 times each day for the full 6 weeks, making sure to fully relax muscles between stretches. Several different tests and questionnaires were administered to determine each subject's total pain score after the 6-week study period. Researchers used SPSS to analyze the raw data collected in the study, finding the ANOVA and Pearson's correlation coefficient. This study is unique in that it does not only consider immediate effects, but allows for an extra 3 weeks after treatment before the follow up assessment (Edwards & Knowles, 2003).

After analysis of results, no significant difference was measured between the groups after the first 3 weeks, but a significant improvement was seen in group 1 after the second 3 weeks, indicating that patients who received both needling and stretching exercises continued to improve in the weeks following treatment. While some improvements were observed from stretching alone in group 2, group 1 was the only population in which the changes seen correlated significantly in the proposed direction. This may indicate that deactivation of trigger points prior to stretching is necessary for effective recovery and resolution of the energy crisis. In group 2, the subjects demonstrated that stretching without first deactivating the trigger points fails to significantly reduce trigger point sensitivity let alone resolve the condition. While none of the groups showed significant reduction in trigger point sensitivity, pain scores were improved most obviously in group 1 who received both DN and stretching exercises, therefore researchers concluded the greatest benefits with DN and stretching (Edwards & Knowles, 2003).

DN, Exercise Therapy, and Electronic Stimulation

Hosseini, Shariat, Ghaffari, Honarpishe and Cleland (2018) performed research on a 43-year old male subject who had history of chronic radicular lower back pain extending to his left leg (Hosseini, Shariat, Ghaffari, Honarpishe & Cleland, 2018). Prior to treatment, the man spent 9 hours per day sitting in an office, had a 60% disability score, and noted that his pain led to numbness and paresthesia and was exacerbated while sitting versus standing. After numerous scans, researchers found a protruded disk in the man’s lumbar spine. The subject was able to perform full lumbar flexion, but reported a 9 out of 10 level of pain. A treatment program was designed including therapeutic exercises, dry needling, and four sessions of nonfunctional electrical stimulation. Exercise therapy is often used to treat lower back pain. It has been shown to improve flexibility as well and strength and endurance, thereby improving physical function and ability to perform activities of daily life. DN is another method of treatment that has been commonly used in management of lower back pain by targeting trigger points. Electrical stimulation is also used in reducing lower back pain by stimulating nerves with electrical current and has been found to help strengthen trunk muscles (Hosseini et al., 2018).

Following treatment, the patient’s pain scores were significantly reduced from a 9 out of 10 to a 2 out of 10 on the numeric rating scale. The patient was able to perform full lumbar flexion without any pain and trigger points were no longer observed. In other existing studies discussed by Hosseini et al. (2018), exercise therapy has been found to reduce lower back pain, and dry needling has been proven to reduce pain intensity while its effect on lumbar spine functionality is not yet confirmed. Previous research on electrical stimulation paired with exercise in individuals with lower back pain has merely been found to show short-term improvements in pain. Researchers in the present study concluded that the combination of exercise therapy, DN, and electrical stimulation was successful in pain reduction and increased ROM in an individual with lower back pain. The positive results from this study were likely due to the conjunction of these three modalities rather than one modality that was superior to the others (Hosseini et al., 2018).

Electrical DN, Exercise, Manual Therapy, and Ultrasound Therapy

Dunning et al. (2018) compared the effects on pain, function, and disability in a treatment program including manual therapy, exercise, and ultrasound either with or without the addition of electrical DN (Dunning et al., 2018). The study was conducted on 111 subjects aged 18 years or older with plantar fasciitis. Researchers set out to determine whether or not the addition of DN would help provide more beneficial and long-term effects as opposed to that of corticosteroid injections. Since no previous studies have investigated this combination of modalities, researchers sought to determine whether the addition of electrical DN would be more effective to the treatment of patients with plantar fasciitis. Researchers hypothesized that the inclusion of electrical DN would lead to reduction in pain and disability in this population of subjects (Dunning et al., 2018).

All participants were involved in up to 8 treatment sessions over a 4-week period and were given an exercise program, manual therapy, and therapeutic ultrasound. The exercise program included stretching and strengthening exercises for the targeted region and was progressed accordingly. Subjects were instructed to complete their prescribed exercises at home 3 times per day. Group 1 received DN in addition to the other exercises and treatments while group 2 did not. Patients of group 2 received dry needling treatment 1-2 times per week for 4 weeks using three different sizes of sterilized disposable needles. Once inserted, the needle was pistoned in and out of the muscle until an aching, tingling sensation was felt, at which time the needles remained inserted with electrical stimulation for several minutes. After evaluating both groups 3 months post-treatment, a significantly greater amount of patients in the dry needling group had cut out their pain medication entirely as opposed to the other group. Additionally, only 21% of patients in group 2 reported a successful outcome as opposed to a significantly higher 77% in the dry needling group. Ultimately, researchers' hypothesis was proven. Their findings confirmed that those who received dry needling demonstrated greater improvements in pain, function, and disability as well as overall quality of life and the amount of pain-related medications taken (Dunning et al., 2018).

Dry Needling, Manual Therapy, and Exercise

Tejera-Falcón et al. (2017) created a treatment protocol for individuals aged 18-65 years old to determine the effectiveness of DN when paired with a manual therapy and therapeutic exercise protocol. All participants must present chronic shoulder pain caused by MTrPs. Subjects will be divided into two groups. Group one will receive 6 weeks of DN, manual therapy, and therapeutic exercises, while group two (control group) will receive 6 weeks of sham DN with manual therapy and therapeutic exercises. Patients in group one will receive DN from an experienced clinician using the pistoning method, in which the needle insertion will be repeated 12 times in each muscle. The control group will receive the same treatment but fake needles will be used as a placebo. Since the pairing of manual therapy with an exercise program has proven effective in improving pain, ROM, and functionality as opposed to exercise alone, these two modalities will be included in the treatment protocol for both groups. Manual techniques such as trigger point pressure release, massage, and various shoulder mobilization movements will be implemented in 45-minute sessions. Monitored exercise sessions will last 25 minutes, consisting of exercises such as scapulohumeral stabilization, rotator cuff and scapular strengthening, and exercises to increase mobility of the glenohumeral joint capsule. Exercises are also to be performed at home throughout the week with progressive increased intensity every two weeks. Participants of this study will be post-tested 6 months following treatment (Tejera-Falcón et al., 2017).

Manual therapy paired with exercise has been shown to be efficacious for patients with chronic shoulder pain and DN is recommended for patients with MPS. Therefore, Tejera-Falcón et al. (2017) predict that this study will reveal beneficial treatment outcomes following one session of DN when paired with manual therapy and therapeutic exercise to reduce pain and improve function in patients with chronic shoulder pain related to MTrPs (Tejera-Falcón et al., 2017). This study is still in the phase of recruiting subjects. Results published upon completion will serve as a new contribution to this field of treatment and may help provide an alternative option to more aggressive treatment such as surgery (Tejera-Falcón et al., 2017).

Conclusion

The theories and scientific background of TPDN as well as the professional findings of various case studies indicate the benefits of utilizing DN alongside physical therapy treatments for maximum healing and recovery. MTrPs typically develop as a result of mechanical overload, psychological stress, sedentary lifestyle, or extended periods of time spent in static posture leading to muscle tightness. Many modalities have been proven effective in the treatment of MTrPs, each having different benefits. DN alone has been proven to be effective in local oxygenation and pain reduction, as well as improving ROM, quality of life, and overall functionality. Ultrasound therapy has been found to help increase ROM and decrease pain and muscle spasms through vasodilation, increased metabolism, and viscoelasticity. Manual pressure, in which the therapist applies pressure directly at the trigger point site, releases muscle spasms, increases pressure pain threshold, and reduces muscle stiffness. Foam rolling is performed independent of the clinician and has been proven to increase ROM, reduce muscle soreness, and improve arterial function and nervous system activity. Instrument-assisted soft tissue mobilization using a beveled bar tool to break up MTrPs leads to increased pain pressure threshold, increased blood flow and ROM, and reduced pain and muscle spasms. Overall, DN may be considered superior because it allows the clinician to target a very small region in a short amount of time. This technique has been proven to be very effective both acutely and chronically. Ultimately, pairing DN with other therapeutic practices may prove to be most effective. The benefits of DN has been proven to be greater when paired with other MTrP release techniques, perhaps by reinforcing the positive effects of myofascial release. Future research may focus on comparing different techniques on different specific populations of patients. One potential study could investigate the effects of DN in post-surgical patients, as opposed to pediatric patients or elderly patients. This may then be compared to differences in the effectiveness of each treatment modality in these populations in order to identify which modality is most effective for each population respectively.

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